Space Weather Technical Forecast

Issued on Monday, 27 December 2021 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active electron fluence likely Day 1 and 2 (27th and 28th). Chance (30%) of G1/Minor Geomagnetic storm later on day 2 (28th).
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with occasional C-class X-ray flares observed at GOES 16 in the period. The largest of these flares reached C3.3 at 26/2012UTC, and appeared to be tied to a filament eruption from the environs of AR2920.
There are currently six active sunspot regions on the visible disc with two new Beta/Bxo regions developing in the northwest quadrant, but conversely 2912 faded to plage during this period. The disc is dominated areally and in terms of complexity by two large sunspot groups - firstly AR2916 in the southeast, which was assessed as an Ehc/Beta remained large but relatively stable. Whilst AR2918 in the north reduced in size somewhat but remains busy with a Dai/Beta classification. Another region of note is AR2920, in the southwest quadrant, which has continued to develop through the period to be classed Cri/Beta. AR2919 in the eastern hemisphere remains a simple unipolar Hrx/Alpha spot.
A filament eruption tied to the largest flare of the 24 hours, mentioned above, has been analysed, Much of the ejecta material is forecast to miss ahead of Earths orbit, but confidence is low and there is a chance of a glancing blow on the 30th December. No other Coronal Mass Ejections (CMEs) were observed in the available imagery during the period.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, remained slow but with a slight rise in speeds towards the end of the period. Density was generally average or below average, but suddenly increased above average at 27/0838 UTC, with a peak of 37 ppcc at 27/1110 UTC. At a similar time the IMF increased from Weak to Moderate, ranging from 8 to 15 nT, with moderate deflection of +/-10nT in the north-south component from 27/0838 UTC. The phi angle fluctuated throughout the period. This sudden jump in density and magnetic field could be associated with one of the CME events from the 21st/22nd December, however geomagnetic activity remained Quiet (Kp 1-2) throughout the period.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels.
The high energy electron flux (greater than 2 MeV) reached High levels between 26/1100UTC and 2120UTC, peaking at 2080pfu at 26/1630UTC, and from 27/1125 UTC. The associated 24-hour integrated fluence remained close be just below the 1e8 Active threshold. At 27/0000UTC the observed fluence was 8.51e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low solar activity is forecast throughout the period, but with a daily chance of increasing to Moderate, with isolated M-class flares, most likely from AR2916 and AR2918. No significant regions leave the disc in the period, but no significant regions are expected to rotate on either.

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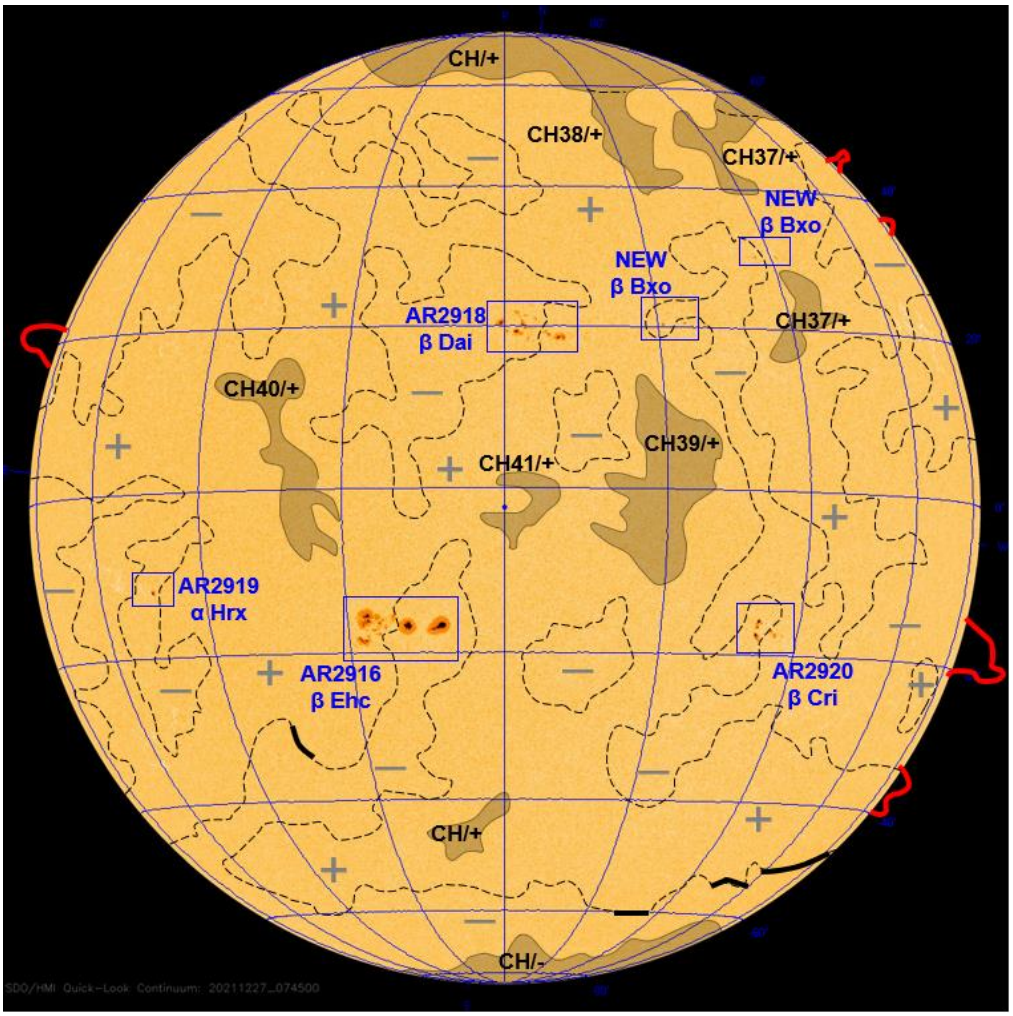
Solar Wind / Geomagnetic Activity: There are two potentially Earth-directed CMEs, which may cause weak glancing impacts at the start of the period. Another CME may produce a further glancing blow on day 4 (30th), but confidence is low. Otherwise, the solar wind is expected to become elevated from late on day 2 (28th) due to CH39 and then prolonged by CH41 for much of the rest of the period. Quiet to Unsettled geomagnetic activity is generally expected, but isolated Active intervals are possible later on day 2 (28th), with a chance of G1/Minor Geomagnetic Storms. This risk should wane through days 3 and 4 (29th and 30th), with predominantly Quiet activity expected by the end of the period, presuming no further enhancement is provided by the CME from the 26th.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels with a daily Slight Chance of S1 should there be any significant flare activity.
High energy electron flux (greater than 2MeV) levels are now expected to be higher in the period, and the electron fluence is likely to breach the Active threshold on days 1 and 2 (27th and 28th). There should then be a hiatus due to the onset of CH39 through midweek, but perhaps recovering slightly by the end of the four days.

Figure 1. Solar Analysis Valid 27/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two CMEs which left the Sun on 21 and 22 December respectively. These may glance the Earth on day 1 (27th), giving a slight chance of G1. However, as both were relatively narrow features, there is low confidence in this aspect of the forecast. Another glancing blow is possible on day 4 (30th) from a CME filament eruption which occurred 26/2012UTC. This is currently forecast to miss Earth. but again confidence is low.
Earth is currently sampling a slow solar wind environment, albeit possibly slightly disturbed by one of the CMEs mentioned above. The latest STEREO A MAG and PLASTIC data suggest a high speed stream has been affecting the satellite since the start of the UTC day of 26 December, which implies a positive polarity high speed stream of the order of 500km/s arriving at Earth on day 2 (28th) (given the 2.7-day lag). This is probably the fast wind emanating from CH39, with CH37 and CH38 perhaps too far pole-ward to feature in the forecast. This may form a more lasting fast wind feature than previously anticipated, with continued enhancement from CH41 likely to soon follow. These coronal holes are not persistent features, and as such confidence in expected geomagnetic activity is low, but a chance (30%) of G1 is proposed, the risk probably peaking with onset later on day 2 (28th). A tailing off of this risk is forecast for the middle of the UTC week, with Quiet geomagnetic activity having resumed to end the four days, presuming no further enhancement is provided by the CME from the 26th.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	30	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Radio Blackouts - X-Ray Flares:

Solar Activity has been Low, with several small C-flares. Background X-ray flux recorded at GOES 16 showed an overall slight decline in the 24 hours, perhaps in part because of the departure of Ex-2907 over the southwestern horizon. The current Earth-facing disc is dominated areally by 2916 and 2918, although neither of these regions has delivered the full scope of their class, being Ehc/Beta and Dai/Beta respectively. This may be because they are now mature, and neither has shown any appreciable growth in recent hours. 2920 has continued to develop over the past 24 hours, as increasingly becoming a region of note, and is now classified as Cri/Beta.
Solar activity is likely to remain Low with further C-class flares. There is a daily chance of activity increasing to moderate levels, with isolated M-class flares. These are most likely to come from 2916 and 2918, but 2920 will also need to be monitored if it continues to develop.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	30	25
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at Background levels and will most likely persist as such. There is a Slight Chance of S1 from any notable flares on the disc, perhaps most likely from AR2916 or AR2918 as the rotate into the western hemisphere.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

The diurnal oscillation in high energy (greater than 2MeV) electron flux, as observed by GOES-16 has shown a slight increase over the last couple of days, perhaps a returning to the effects of the earlier 600km/s high speed stream, once the interruption of the most recent 475km/s feature waned. Whatever the mechanism, the chances of Active electron fluence being realised is now substantially higher than in recent guidance, albeit with only minor exceedence of 1e8 fluence likely. The onset of CH39/+ on day 2 (27th), ought to further interrupt this trend, and electron flux and fluence should return to background levels. An increase is likely again towards the end of the period, but perhaps to a lower level.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	60	60	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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